

Benthos of the Muddy Bottom Habitat of the Geelong Arm of Port Phillip Bay, Victoria, Australia.

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Introduction

The subtidal benthos of the Geelong Arm of Port Phillip Bay is known from taxonomic descriptions and species lists from the National Museum of Victoria Survey of Port Phillip Bay 1969 - 1971 (Black 1971), and from surveys of the benthos of Port Phillip Bay by the Melbourne & Metropolitan Board of Works and the Fisheries and Wildlife Department 1968 - 1971, (M&MBW Study, 1973, see Poore *et al.* 1975). These latter surveys, which sought to define the populations and distribution of the infaunal benthos of Port Phillip Bay, included some stations in the Geelong Arm (Poore and Rainer 1974, 1979). Other than monitoring the scallop populations off Portarlington for the commercial fishery (e.g. Smith and Bury 1991), there have been no quantitative studies of the distribution of the soft bottom epibenthos of this area. The present study deals with the species, abundance and distribution of both the infauna and selected epibenthos of the muddy habitat of the Geelong Arm.

Environment of the Geelong Arm

The central axis of the Geelong Arm comprises three basins: the well-defined Corio Bay (to 9 m depth), and two, less well-defined in Outer Harbour, one extending from Point Henry to Point Wilson (to 8 m depth), and the second merging eastwards from Point Wilson into wider Port Phillip Bay between Portarlington on the Bellarine Peninsula and Little River on the northern coast (to 11 m depth) (Fig. 1).

Water circulation in the Geelong Arm is driven by both tide and wind; peak tidal flows being generally less than 20 cm/s, water movement decreasing westwards into Corio Bay. Strong north-easterly and

westerly winds may induce surface current speeds of up to nearly 50 cm/s (A. McCowan, pers. comm.)

The sea bed of the central axis of the Geelong Arm is uniformly flat and topographically featureless, the sediments consisting of semi-compacted grey clay mixed with varying proportions of aged to sub-fossil shell.

Sampling of the benthos was undertaken in February-March 1992 in six fixed areas and at 24 randomly chosen sites within these areas (Fig. 1). Sampling sites were positioned by Global Positioning System (GPS).

Epibenthos

Most of the dominant epibenthos of the muddy bottom of the Geelong Arm are species common to similar habitats in Port Phillip Bay.

Plants include sparsely distributed patches of the marine angiosperm *Halophila australis* Doty & Stone and the green alga *Caulerpa remotifolia* Sonder. Common sessile invertebrates include several species of sponges, the ascidians *Pyura stolonifera* subsp. *praeputialis* Heller and *Sycozoa pedunculata* (Quoy and Gaimard), and a colonial polychaete provisionally identified as *Sabella spallanzanii* Gmelin. Motile animals include the holothurian *Stichopus mollis* (Hutton), the sea stars *Patiriella brevispina* H.L. Clark and *Tosia australis* Gray, and the commercial scallop *Pecten alba* Tate. The fragile bivalve *Electroma georgiana* (Quoy and Gaimard) and the hydroid *Obelia australis* Lendenfeld are seasonally common (Watson unpubl.), and large populations occurring over the summer months.

Methodology

Selected visually dominant and easily quantifiable epibenthic species were

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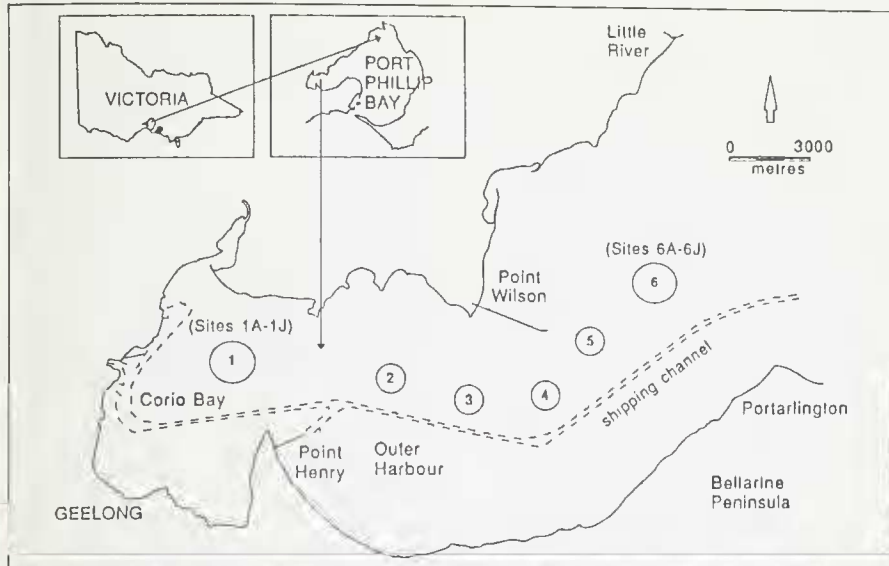


Fig. 1 Map showing location of sampling areas and sites in the Geelong Arm of Port Phillip Bay.

counted by a biologist-diver at each site. Leaf density of *Halophila australis* was estimated over four randomly placed replicate quadrats each of 0.25 m^2 , the number of leaves in each quadrat being counted. Colonies of *Sabella spallanzanii* were quantified by recording the intercept distance covered by each colony along a 25 m line transect. Individuals of *Pyura stolonifera* were counted over a belt transect of $25 \times 1\text{ m}$, and scallops over a similar transect of $50 \times 1\text{ m}$.

The multivariate technique of non-metric multidimensional scaling (NMDS) was used to provide an insight into distribution of the epibenthos. The ordination was based on a dissimilarity matrix of Manhattan distance measures, where distance $(x,y) = \sum_i |x_i - y_i|$.

Results and Discussion

Halophila australis was present in quantifiable densities only in Area 1 in Corio Bay (Table 1). Although isolated plants were observed at some of the easterly areas, none were recorded from the quadrats. Leaf densities in Area 1 ranged from $0\text{--}445/\text{m}^2$ with a mean density of

$131/\text{m}^2$ ($\text{SD} = 158$). Plants were most abundant in the south-east of Area 1 (Sites 1B,D,H,J). This area has relatively greater tidal and wind-generated water circulation than most of Corio Bay.

Halophila australis is a cool temperate species ranging from the South Australian gulfs to New South Wales (Shepherd 1983; Shepherd and Robertson 1989; Robertson 1984). Plants are pioneer colonisers of barren areas (Walker 1989; Clarke and Kirkman 1989). In sheltered Victorian waters growth of *H. australis* is limited by irradiance to a depth of about 8 m. It prefers muddy or silty bottom, often occurring as a sparse fringe on the seaward side of *Heterozostera* meadows (Bulthuis 1981). It occurs along the northern and southern coastlines of the Geelong Arm and in Swan Bay on the eastern side of the Bellarine Peninsula (Black 1971). It is a seasonal plant (West *et al.* 1989) with maximum growth over the summer months (H. Kirkman pers. comm.). The plants grow from a slender stolon embedded in the substrate, the shoots bearing paired leaves (Robertson 1984).

The polychaete *Sabella spallanzanii* is the visually dominant organism of the muddy bottom habitat. The colonies distributed in patches, consist of closely aggregated clusters of one to 30 individuals growing to a height of about 30 cm above the substrate (Fig. 2). Each silt-coated tube is surmounted by a crown of buff-coloured feathery brachioles. Masses of green-coloured eggs are released in late summer.

The mean number of colonies per transect over all sites was 8 (SD = 7) (Table 2), approximately equivalent to one colony every 3 m. In Corio Bay (Area 1) the number of colonies varied from 0 in shallower water (Sites 1B, 1I) to 22 at Site 1C in quieter water, the mean number of colonies per transect being 10 (SD = 8). In Outer Harbour, the number of colonies ranged from one (Site 6F) to 27 (Site 3) with a mean of 7 colonies per transect (SD = 7).

Table 1. Distributional data of selected species, Geelong Arm

<i>Halophila australis</i>	- no. of leaves per m ²
<i>Pyura stolonifera</i>	- no. per 25 m transect
<i>Pecten alba</i>	- no. per 50 m transect

Area /Site	<i>Halophila australis</i>	<i>Pyura stolonifera</i>	<i>Pecten alba</i>
1A	0	0	0
1B	186	0	0
1C	0	2	0
1D	278	1	0
1E	0	0	0
1F	49	0	0
1G	52	0	0
1H	445	5	0
1I	14	0	0
1J	288	2	0
2	0	2	5
3	0	3	0
4	0	5	74
5	0	29	152
6A	0	128	31
6B	0	0	47
6C	0	11	18
6D	0	2	20
6E	0	16	109
6F	0	11	85
6G	0	36	18
6H	0	5	85
6I	0	68	39
6J	0	86	16
Total	1312	412	699
Mean	55	17	29
SD	119	32	42



Fig. 2 Photograph of sea bed in Corio Bay showing colonies of *Sabella spallanzanii*. Depth 4 m.

Mean colony width over the entire survey area was 9.6 cm, that in Corio Bay being 11.4 cm, and in Outer Harbour, 6.4 cm. The largest colonies recorded, with a mean width of 50 cm, occurred at Site 2 in Outer Harbour.

Sabella spallanzanii has not previously been recorded from Australia (e.g. Pollard and Hutchings, 1990); it is known from the Mediterranean Sea, the English Channel, North Africa, Rio de Janeiro, and south-east Asia (Knight-Jones, pers. comm.). It is not recorded from earlier surveys of Port Phillip Bay, nor was it seen in Corio Bay by the authors or others (A. Stevens, pers. comm.) before the early 1980s. Its present density and visual dominance suggests that it may be an introduced species that has proliferated in the muddy habitat and calm environment of the Geelong Arm. The tubes of the larger colonies provide habitat for many sessile species (filamentous red algae, hydroids) and sedentary species (gastropod molluscs, sea stars, crustaceans) common in Port Phillip Bay. If indeed introduced, there is not apparent evidence of it having displaced any indigenous species from their habitat.

Mean populations of *Pyura stolonifera* varied from 1/25m² (SD = 1) in Area 1 to 29/25m² in Outer Harbour, with a mean density of 17/25m² (SD = 32) over the entire survey area (Table 1). The highest population was at Site 6A where a mean density of 128/25m² was recorded.

Pyura stolonifera is one of the most abundant and widely distributed ascidians in embayments along the southern Australian coastline, being recorded from south-western Australia to southern Queensland (Kott 1976). It is especially abundant in Port Phillip Bay and Western Port (Millar 1966; Black 1971; Watson unpubl.) where it colonises a range of sediments from compacted muds to sandy bottom. Larvae settle on old shell and mature in one to two years to either solitary, or clusters of individuals that may stand more than 10 cm above the substrate. The leathery test of the adult organism provides substrate for a wide variety of algae and sessile invertebrates. In many parts of Port Phillip Bay where reef habitat is absent it is an important primary substrate, forming numerous 'micro-reefs' which are substrate for many other species (Watson unpubl.). Its importance as substrate and habitat for epibenthic organisms in otherwise barren areas of the bay has never been explored.

Table 2. Total intercept length (cm), number, mean width (cm) and standard deviation of *Sabella spallanzanii* colonies per 25 m line transect.

Area/Site	1A	1B	1C	1D	1E	1F
Intercept	136	0	234	167	60	71
Number	8	0	22	14	4	17
Mean width	17	0	11	12	15	4
Std.dev.	19	0	15	14	27	6

Area/Site	1G	1H	1I	1J	2	3
Intercept	372	2	0	87	150	88
Number	16	1	0	17	3	27
Mean width	23	2	0	5	50	3
Std.dev.	37	0	0	6	69	4

Area/Site	4	5	6A	6B	6C	6D
Intercept	92	175	21	12	2	38
Number	8	9	14	4	2	4
Mean width	12	19	2	3	1	10
Std.dev.	12	25	1	3	0	8

Area/Site	6E	6F	6G	6H	6I	6J
Intercept	25	2	30	3	90	64
Number	5	1	8	3	7	7
Mean width	5	2	4	1	13	9
Std.dev.	6	0	5	0	14	8

Density of *Pecten alba* ranged from 0 to 150/50m² at Site 5, with an overall mean of 29/50m² (SD = 42) (Table 1). No scallops were recorded from Area 1. At Sites 6A-6J off Portarlington, mean density was 47/50m². All scallops were about 70 mm in width and thus about 18 months old (Gwyther and McShane 1988). The difference between the mean population density recorded in the present survey and the mean of 0.09/m² found in the Geelong Arm by Smith and Bury (1991) may be due to distributional patchiness, suggested by the large standard deviation (Table 1).

The NMDS ordination, using the number of colonies of *S. spallanzanii*, shows sites with highest plant density of *H. australis* on the right hand side of the plot (Fig. 3). These sites are shallow and

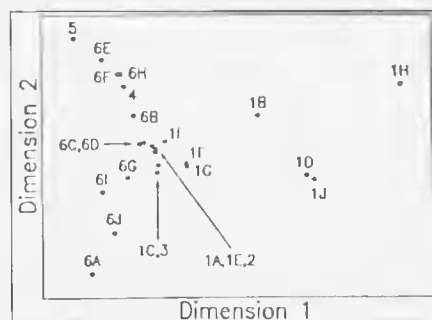


Fig. 3 NMDS ordination of sites on basis of epibenthos (stress = 0.02).

are the ones most exposed to water movement in the entire survey area. The mutual exclusivity shown between *H. australis* and scallops (see also Table 1) is probably indicative of increasing water depth eastwards in the Geelong Arm. The general increase in *P. stolonifera* numbers and decrease in size of colonies of *S. spallanzanii* eastwards from Corio Bay suggests that the former requires good water movement while the latter prefers quieter conditions.

With the possible exception of *S. spallanzanii*, the epibenthic community of the Geelong Arm consists of species common throughout Port Phillip Bay. However, the relative abundance of the species comprising the community probably differs from other parts of the

Bay. However, the relative abundance of the species comprising the community probably differs from other parts of the bay. Unlike the meadow-forming seagrasses of the *Zosteraceae* bordering much of the Bellarine coastline, the small size and sparse cover of plants of *H. australis* makes it unlikely that this marine angiosperm is an important fish habitat.

Infauna

Methodology

At Sites 1A, 1J, 2, 3, 4, 5, 6D and 6G, infauna was sampled from an area of 0.1m² to a depth of 10 cm by a biologist-diver using a water-venturi suction sampler. Samples were sieved through a mesh of 710 μ m and preserved in a 10% formaldehyde solution. In the laboratory, organisms were sorted from the sediment matrix, identified to higher taxonomic group under stereomicroscope and counted.

An NMDS plot of Manhattan distance measures, similar to that used for epibenthos, was used for interpretation of infaunal distribution.

Results and Discussion

The infauna comprised the major phyla normally associated with soft bed habitat. The number of species per site of 0.1m² ranged from 41 (Site 6D) to 74 (Site 3) with a mean of 52 (SD = 10).

Populations ranged from 718 at Site 6D to 1252 at Site 5 with a mean of 945 (SD = 200) (Table 3).

Polychaetes were the predominant group with 44% of the overall population and a mean of 21 species per 0.1m² (Fig. 4).

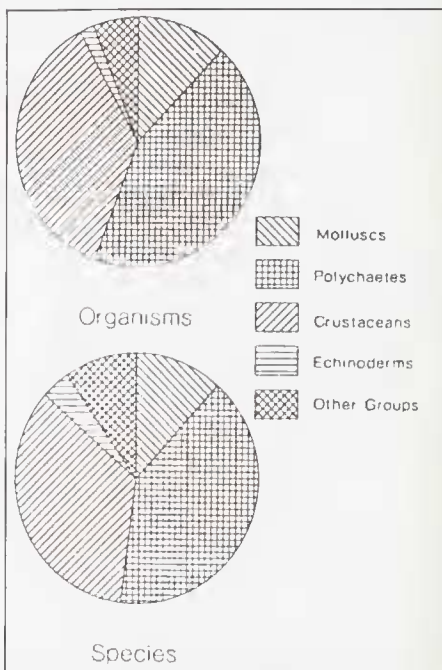


Fig. 4 Pie diagrams showing species composition and abundance of the infauna in Geelong Arm.

Table 3. Distributional data of infauna, Geelong Arm. Number of organisms and species per site of 0.1m²

Taxon	1A	1J	2	Area/Site		5	6D	6G	Mean	SD
				3	4					
Mollusca										
organisms	273	274	5	47	118	89	36	65	113	104
species	6	5	4	9	8	6	5	6	6	2
Polychaeta										
organisms	352	633	602	475	356	487	142	245	412	170
species	17	22	20	33	18	16	19	19	21	5
Crustacea										
organisms	94	94	119	309	605	587	467	469	346	221
species	17	13	17	21	18	18	14	22	18	3
Echinodermata										
organisms	14	5	24	56	29	12	0	1	18	19
species	3	3	3	3	3	3	0	1	2	1
Minor Groups										
organisms	32	45	84	28	88	77	73	20	56	28
species	4	4	8	8	6	5	3	5	5	2
Total										
organisms	765	1051	834	915	1196	1252	718	827	945	200
species	47	47	52	74	53	48	41	53	52	10

Population densities ranged from 142 (Site 6D) to 633 (Site 1J) with a mean of 412 (SD = 170). The most numerous polychaetes were *Nephtys inornata* Rainer & Hutchings, *Tharyx* sp., *Leitoscoloplos bifurcatus* Day, *Armandia* sp. and *Polophthalmus pictus* (Dujardin).

Crustaceans were the next most abundant group with 37% of the populations and a mean of 18 (SD = 3) species per 0.1m². Population densities ranged from 94 organisms per site (Sites 1A, 1J) to 605 (Site 4) with an overall mean of 346 (SD = 221). The predominant crustacean was the cumacean *Dimorphostylis cottoni* Hale, which comprised 24% of the total infaunal population over the entire survey area; it was most abundant at Sites 4, 5, 6D and 6G in Outer Harbour but was rare in Area 1.

Molluscs were the third most abundant group with 12% of the population and a mean of 6 species (SD = 2). Population densities ranged from 5 (Site 2) to 273 and 274 (Sites 1A and 1J) with a mean of 113 (SD = 104). Bivalves were the dominant molluscan group, the high numbers in Area 1 being mainly due to *Theora lubrica* Gould. The nesting mussel *Musculista senhousia* (Benson in Cantor), was common at Site 1J. Other common bivalves were *Fulvia tenuicostata* (Lamarck 1819) and *Tellina mariae* (Tennison Woods 1875). *Anisodonta subalata* (Gatliff and Gabriel 1910) from Site 6G is a rare species. Juvenile opisthobranchs *Liloea brevis* (Quoy & Gaimard), were recorded in numbers ranging from 13 to 72 at various sites. Gastropods were rare and represented mainly by *Diala lauta* Adams.

Echinoderms comprised 2% of the populations with a mean of 2 species at each site while the minor groups, with 4% of the populations were present with at least eight species groups. The most abundant echinoderms were the ophiuroids with a mean of 16 individuals per site. Echinoids, represented solely by the burrowing species *Echinocardium cordatum* (Pennant), were uncommon, but

were more plentiful in Area 1 than elsewhere.

The NMDS ordination (Fig. 5) shows a separation along Dimension 1, between sites east of Point Wilson and those to the west. This division may be attributable to greater water exchange at these sites with wider Port Phillip Bay.

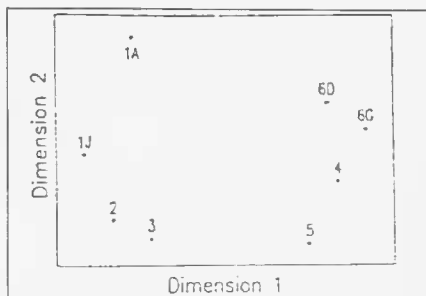


Fig. 5 NMDS ordination of sites on basis of infauna (stress = 0.02).

Five stations sampled for infauna in the Geelong Arm by the M&MBW Study (1973) (Poore *et al.* 1975), are geographically comparable to the present study. These authors gave a range of 118-462 organisms/0.1m² and 57-87 species per site of 0.5m². Sampling on 11 occasions of one site in Corio Bay (Stn 940) near Sites 1A and 1B of the present survey (see Table 3) between 1973 and 1975, resulted in an overall mean of 89 organisms and 19 species/ 0.1m² (Poore and Rainer 1979). Since seasonal variation in populations was determined to be insignificant by these authors, the much greater infaunal populations recorded in the present study may be due to more intensive sampling techniques.

Musculista senhousia was introduced to Western Australia from Asia or New Zealand about 1982 (Willan 1987). *Theora lubrica*, also introduced from Asia (Chalmer *et al.* 1976), was probably recorded as *Theora fragilis* by Poore and Rainer (1979).

Acknowledgements

We are grateful to Dr Andrew McCowan of Lawson and Treloar Pty Ltd Melbourne

for hydrodynamic data, to Dr Hugh Kirkman of CSIRO Perth, to Dr Phyllis Knigh-Jones of the University of Swansea Wales, for polyshaete identification; to Drs Robin Wilson and Gary Poore and Mr R. Burn of the Museum of Victoria for identification of specimens, and to Mr Andrew Stevens of the Environmental Protection Authority of Victoria for historical information. We thank Maunsell Pty Ltd Consulting Engineers, Melbourne and the Port of Geelong Authority for permission to publish the data.

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